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TOWARDS A CHARACTERIZATION OF ARCTIC MIXED-PHASE CLOUDS

Shupe, M.
CIRES/NOAA/ETL

Kollias, P.
Brookhaven National Laboratory

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Environmental Sciences Department/Atmospheric Sciences Division
Brookhaven National Laboratory
P.O. Box, Upton, NY
www.bnl.gov

ABSTRACT

Mixed-phase clouds play a unique role in the Arctic, where the delicate balance of phases in these clouds can have a profound impact on the surface radiation balance and various cloud-atmosphere-radiation-surface feedback processes. A better understanding of these clouds is clearly important and has been a recent objective of the ARM program. To this end, multiple sensors including radar, lidar, and temperature soundings, have been utilized in an automated cloud type classification scheme for clouds observed at the North Slope of Alaska site. The performance of this new algorithm at identifying mixed-phase cloud conditions is compared with an existing, manual classification of cloud phase. Using collocated cloud radar and depolarization lidar observations, it is shown that mixed-phase conditions have a high correlation with a broadened radar Doppler spectrum with, a relationship that can be useful, under some circumstances, in identifying mixed-phase conditions from radar measurements alone. Mixed-phase clouds are observed in all seasons at the NSA site, with the most frequent occurrence in the spring and fall transition seasons. These clouds occur nearly 30% of the time near the surface with the frequency decreasing in the vertical to zero at a height of nearly 7 km. Mixed-phase clouds are, on average, the warmest, thickest, and highest in the middle of summer. In addition, microphysical properties of mixed-phase clouds observed at the NSA site from March 1998 through December 2004 are derived using statistical, radar-based retrieval methods. On average, mixed-phase cloud ice particle mean diameters increase from ~50 microns in winter to ~120 microns in summer with an annual mean of 87 microns. The average mixed-phase cloud ice water path undergoes a small annual trend, with the largest values observed in summer and fall, and an annual average of 55 g/m^2. The liquid water path in these clouds is, on average, about 40 g/m^2 in winter increasing to nearly 100 g/m^2 in late summer, with an annual average of 70 g/m^2. The variation of these parameters from year-to-year at the NSA site, and in comparison with similar observations from the SHEBA experiment, will be presented. Initial estimates of vertical air motions in mixed-phase clouds, derived from radar Doppler spectra, will also be presented.